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Clifford H. Pope
Chicago Natural History Museum

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A Statistical and Ecological Study of the Salamander *Plethodon yonahlossee*

Clifford H. Pope

Chicago Natural History Museum

Grobman's stimulating paper on the eastern salamanders of the genus *Plethodon,* published in 1944, has aroused considerable interest in the evolution of the group (Hairston and Pope, 1948; Deevey, 1949). It has become apparent that more valid conclusions on the phylogeny and evolution of the group as a whole must await the accumulation of much additional comparative data on the structure, ecology, and associations of the forms involved. To this end, I have begun a series of detailed studies of the more important forms (Pope and Pope, 1949).

In 1917, Dunn pointed out the primitive characteristics of *Plethodon yonahlossee,* and later (1926, p. 133) concluded that it is probably the most primitive member of the genus. It is, therefore, a form worthy of detailed investigations. To my mind the mere fact that it ranks high as one of the handsome and conspicuous vertebrate elements of our southeastern mountain-woodland fauna warrants this study.

The field work on which this paper is based was done during my 1949 sojourn at Mountain Lake Biological Station, Giles County, Virginia. I am indebted to Director Bruce D. Reynolds, who put the facilities of the station at my disposal and cooperated in every way possible. For assistance in collecting I am indebted to Dr. L. James Kezer, Perry C. Holt, and my son, Whitney. Dr. Kezer also helped in examination of gonads; Robert F. Inger advised on statistical treatment; my son, Hallowell, calculated the means and standard errors; Henry S. Dybas made the identifications of stomach contents, and Karl P. Schmidt read the manuscript. My wife, Sarah H. Pope, actually collected a large number of the specimens, assisted in preserving and examining them in the field, and in checking the manuscript. I am deeply indebted for all this invaluable aid.

MATERIAL AND METHODS

Although this salamander was found between Linville and Blowing Rock, North Carolina, as early as 1902 by the late Franklin Sherman who noticed its distinctness, the original specimens, instead of being described, were shelved along with *Plethodon glutinosus* in the United States National Museum until Dunn collected the species near Linville in 1916 and properly described it (1917).

Apparently the scarcity of references to *yonahlossee* has helped to create the widespread impression of its rarity. This impression can no longer stand since several other large series have been preserved though not studied.

The present paper is based primarily on the series of 128 carefully preserved specimens collected in 1949 by me and my associates as detailed below. I have gone through all the literature and used lists of specimens kindly sent me by Arthur Loveridge of the Museum of Comparative Zoology, Cambridge; Charles M. Bogert of the American Museum of Natural History, New York; Dr. Doris M. Cochran of the United States National Museum; and Dr. Norman Hartweg of the University of Michigan, Museum of Zoology. Dr. Sherman C. Bishop of the University of Rochester; James A. Fowler of the Philadelphia Academy of Natural Sciences; and Dr. Arnold B. Grobman of the University of Florida have generously given me lists of additional material. Other preserved specimens undoubtedly exist but I feel that tracking them down would scarcely be a legitimate expenditure of time and energy.

Abbreviations used in the text are: CNHM: Chicago Natural History Museum, and UMMZ: University of Michigan, Museum of Zoology.

Allocation of the four collecting sites listed in Table I will be found in the section on distribution. Any slight discrepancy between the number of specimens listed there and elsewhere in this paper is due to the omission of one poorly preserved individual and two that were discarded in the field.

All the specimens were collected by daylight either during actual precipitation or just after it when the humidity was high and the forest floor well soaked with rain. At such times one gets by far the best results. The collecting was non-selective, i. e., specimens of all sizes were captured just as encountered. The animals were killed with chloretone, stretched out to harden for an hour or two in shallow formalin and, after injection with it, placed either in formalin or alcohol. A few weeks later all were permanently stored in alcohol.

The anterior angle of the vent was used in making the snout-vent measurement with Vernier calipers; the term "length" is applied to this measurement. Tail length was obtained by subtracting this snout-vent dimension from the total length, which was made by stretching the speci-

mens along a half-meter rule. Measurements were originally taken to the nearest 0.5 mm. but those with this fractional value were finally raised to the next whole number. Every arithmetic mean is accompanied by its standard error.

Table I. Summary of the New Material Forming the Basis of this Paper. CNHM nos. 59333-415 and 59417-61

Locality, with altitude in feet	Date collected		Number of specimens
Iron Mt., Tenn., 3200-4300	July 12-14		100
White Top Mt., Va., 3775-5475	Aug. 10-11		6
Buck Mt., Va., 3500-4670	Aug. 17		15
Comers Rock, Va., 3600-4000	Aug. 16		7
		Total	128

All measurements were made after the material had been preserved. Many color notes were written in the field at the time of preservation.

DISTRIBUTION

The range of *P. yonahlossee* lies athwart the Blue Ridge Province from the Swannanoa Mountains (east of Asheville, North Carolina) to Comers Rock ridge of the Iron Mountains (southwest of Wytheville, Virginia). It is found from the extreme western border of the province (Holston Mt., Tennessee) to the extreme eastern one (Mortimer, North Carolina). The localities from which it is known are shown on the spot map (Fig. 1), some half of the eighteen spots representing more than one collecting station. Hereinafter, parenthetical numbers following locality names refer to the numbered localities of the map.

I have taken *yonahlossee* at five of the localities (8, 14, 16, 17, and 18) and examined material from three additional ones (2, 3, and 4). There is no reasonable doubt that identification of the material from the remaining places has been accurate.

The total vertical range extends certainly from 2500 to 5700 feet, possibly from 1500 to 5700 feet (Fig. 1). The Mortimer (6) specimen taken at 1500 feet may have been washed down by a flood (Hairston, 1949, p. 56). The vertical range in the Black Mountains extends from 2500 feet (*op. cit.*, p. 54) to 4700 feet (CNHM 55700). This extent of 2200 feet is not equaled elsewhere. On White Top (16) I collected it over a range of 1700 feet (3775 to 5475) and James A. Fowler added 275 feet by getting it there at 3500 feet (letter of December 12, 1949). On Buck Mt. (17) I took it from 3500 to 4670 feet (range: 1170 feet); on Grandfather (8) it is known from 4000 to 5700 feet, a range of 1700 feet (UMMZ 75496 and CNHM 45920).

Probably the distribution of this species has been about fully delimited. Its known range is bounded on the southeast and northwest by relatively low, non-mountainous areas, the Piedmont and Valley and Ridge provinces, respectively. To the southwest, the valley of the French Broad River is not a formidable barrier but considerable collecting in the Balsam and Great Smoky mountains beyond has failed to discover *yonahlossee.* On the north, it apparently does not reach the mountains around Burkes Garden since I failed to find it there and so have others who collected much longer (Hoffman and Kleinpeter, 1948). Northeast of Buck Mt. (17) and Comers Rock ridge the valley of the New River offers a barrier beyond which *yonahlossee* has never been found.

The species should be hunted in the mountains lying along the Tennessee-North Carolina border and just northeast of the valley of the French Broad River for here a slight extension of the range is to be expected.

ECOLOGY

Incidence. Plethodon yonahlossee's undeserved reputation of being rare is partly due to its relative scarcity in the region of the type locality and at high altitudes. It is a common practice of collectors to search for topotypes, and many collectors feel that a rare mountain species must certainly be most abundant in the highest regions.

The first intimation that *yonahlossee* is not rare everywhere came from Bailey who, in 1937, reported it to be "common" near Swannanoa and Linville Falls (1 and 5) ; soon after, Gray (1939) recorded the capture on Holston Mt. (15) of ten specimens in less than half an hour by two collectors. By contrast, Dunn's original series of twenty-three individuals had required the efforts of two collectors for three full days near Linville (7). Results of the work of my own party at four northern localities are given

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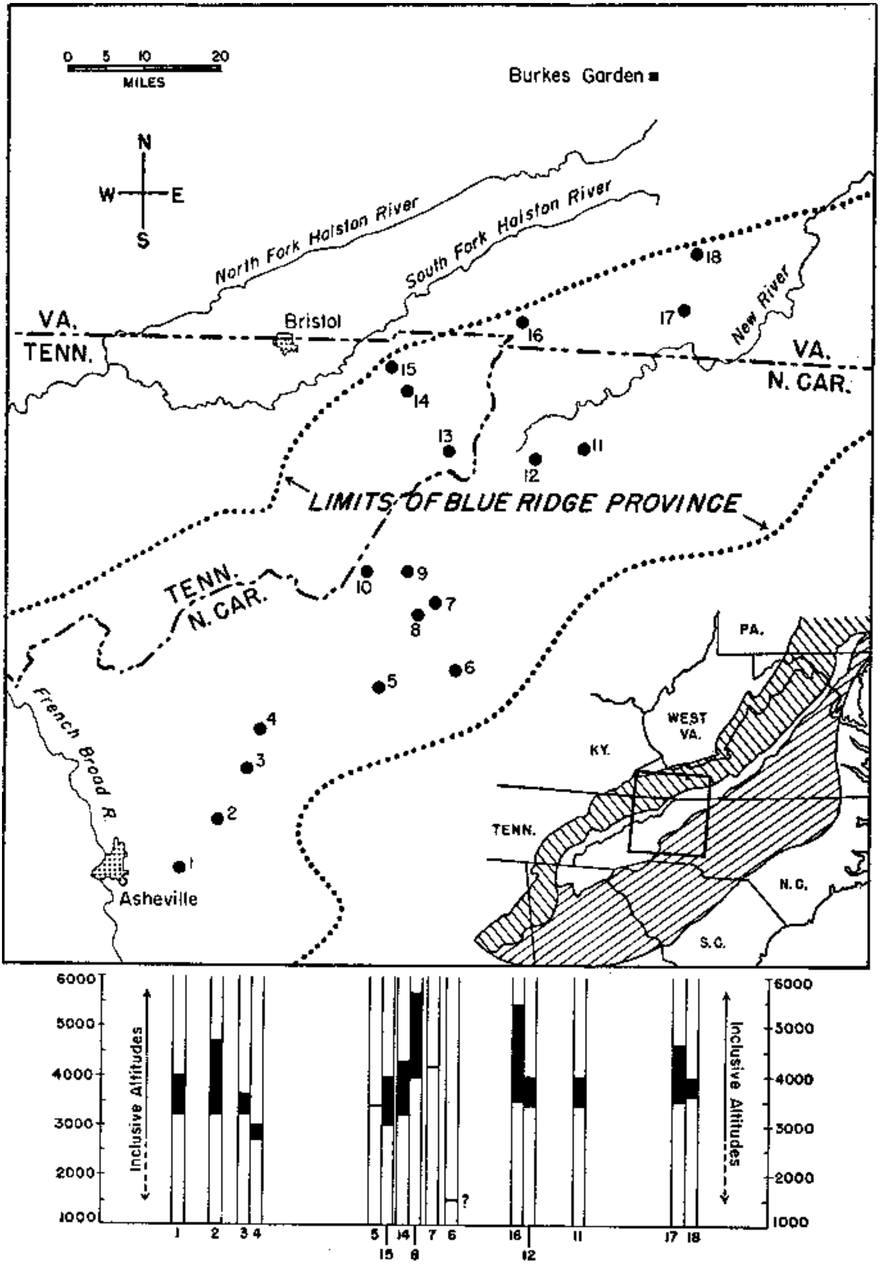
Figure 1. Map of contiguous regions of North Carolina, Virginia, and Tennessee with locality records of *Plethodon yonahlossee* **numbered 1 through 18 as follows: 1: Vicinity of Swannanoa. 2, 3, and 4: Black Mountains. 5: Vicinity of Linville Falls. 6: Mortimer. 7: Vicinity of Linville. 8: Grandfather (Mt.). 9: Banner Elk. 10: Elk Park. 11: West Jefferson (Beaver Creek). 12: Bluff Mt. 13: Six and a half miles south of Mountain City. 14: Iron Mt. 15: Holston Mt. 16: White Top (Mt.). 17: Buck Mt. 18: Comers Rock.**

The inset map shows relationships of the *P. yonahlossee* **distribution to the Blue Ridge Province (unshaded but surrounded by shading), the Piedmont Province (shaded with lines slanting from northeast to southwest) and the Valley and Ridge Province (shaded with lines slanting from northwest to southeast).**

The extent of the vertical distribution at each locality is shown by the numbered bars below the map, the numbers of the bars corresponding to the numbers of the localities on the map. The lowest altitude indicated by these bars is 2700 feet, whereas the text gives 2500 feet. The discrepancy is caused by a literature record (2500 feet) from an inexactly allocated Black Mountain locality, which is either 2, 3, or 4 of the map.


0 5 10 20
MILES
N
W E
S
Burkes Garden
North Fork Holston River
South Fork Holston River
VA.
TENN.
Bristol
VA.
N. CAR.
New River
LIMITS OF BLUE RIDGE PROVINCE
TENN.
N. CAR.
French Broad R.
Asheville
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
PA.
WEST VA.
KY.
TENN.
N.C.
S.C.
6000
5000
4000
3000
2000
1000
Inclusive Altitudes
?

in Table II. This work was done under optimum conditions, i. e., during and between showers of a protracted rainy spell. It should be remarked that the big catch of 101 specimens was made by four workers, one of whom was inexperienced and took less than half as many as any of the others; also, one of the three collectors of August 11 was not experienced.

It is evident that *yonahlossee* must be considered abundant from Holston Mt. (15) eastward to Comers Rock (18) and Buck Mt. (17). Farther south, in the region of Grandfather Mt. (8) and Linville (7) , it is not so abundant, and Hairston has recently (1949) reported it as rare in the Black Mountains (2 and 3) , but Bailey's 1937 reference to it as common to the north and south of this region is somewhat contradictory.

Table II. Record of Collecting at Four Localities.

Locality, with altitude in feet	Date	Man-hours of work	Number taken
Iron Mt. (14) 3200-4300	July 12-14	44	103
White Top (16) 3775-3900	**Aug. 11**	6	5
Buck Mt. (17) 3500-4670	Aug. 17	4.5	15
Corners **Rock** (18) 3600-3700	**Aug.** 16	3	7
	Totals	57.5	130

There is abundant evidence that *yonahlossee* is rare in the balsam-red spruce forests that cap White Top (16). I know of two experienced collectors who looked there for it in vain and of one who found but a single specimen. It was not even secured in two days by a class of students from Mountain Lake Biological Station. My own party of three caught one specimen there at 5475 feet as the result of six man-hours of work by day and three by night. Hairston (1949, p. 55) remarks on its "apparent absence from high altitudes" in the Black Mountains. Presumably the scarcity becomes noticeable between 4500 and 5000 feet.

Association. Since the only closely allied species of *Plethodon* whose ranges appreciably overlap that of *yonahlossee* are *glutinosus* and *metcalfi* (Hairston and Pope, 1948, *fig.* 11) , it is the ecological relationship of these two forms with *yonahlossee* that concerns us here.

The range of *yonahlossee* lies entirely within that of widely distributed *glutinosus,* whereas *metcalfi* is found over only part of the area occupied by *yonahlossee.* This means that *yonahlossee* and *glutinosus* occur together in places where *metcalfi* is lacking, and this simpler association with its three aspects, intimacy, relative abundance, and extent, will be considered first.

1. Intimacy. Gray (1939) "often" found *yonahlossee* and *glutinosus* under the same log on Holston Mt. (15) , whereas, on nearby Iron Mt. (14) we found them closely associated but seldom under the same log. For instance, there, where my total catch of *yonahlossee* was thirty-eight specimens, I twice took the two forms under the same log. It was hard

to detect a difference in habits and habitat preference if the greater agility of *yonahlossee* was left out of consideration. The same similarity of habits and habitat was observed at Comers Rock (18) and Buck Mt. (17) , the other localities where we observed only these two forms.

2. Relative abundance. Table III indicates the relative abundance at the three *yonahlossee-glutinosus* localities, the data representing our actual catch with the exception of the Buck Mt. *glutinosus* count, which is based partly on sight records.

Table III. Relative Abundance of Two Species at Three Sites.

Locality, with altitude in feet	Number of *P. yonahlossee*		Number of *P. glutinosus*
Iron Mt. (14) 3200-4300	103		281
Buck Mt. (17) 3500-4670	15	**about**	23
Comers Rock (18) 3600-3700	7		45

The only information in the literature is Gray's 1939 estimate that the two species are equally abundant on Holston Mt. (15).

3. Extent. At Iron Mt. (14) we collected the two species together from the crest of the ridge (4300 feet) to the 3200-foot level, and certainly did not reach the lowest point for either, nor did we work enough outside of the forest to find any habitat difference there. Our capture of *yonahlossee* in an Iron Mt. pasture is recorded elsewhere, but this pasture was briefly visited and is enclosed by forests. Work at Corners Rock (18) was much too restricted (3600-3700 feet), but in the Buck Mt. area (17) we found the two together from the tip of the mountain (4670 feet) to 3500 feet. Here we did find *glutinosus* abundant at 4300 to 4350 feet on a log-strewn, grassy slope (mentioned in the habitat section) that apparently did not harbor *yonahlossee.* At least, in fifteen minutes, fourteen of the former were taken, whereas the latter was not seen. It is unfortunate that time did not permit us to follow these two species right down to the high valley floors of the Buck Mt. and Iron-Holston mountain regions, where extensive areas lie above the 2000-foot contour and it is possible that *yonahlossee* occurs much more generally than was ever imagined. Its ability to invade open areas is discussed in the habitat section.

Finally, I shall consider the triple association of *yonahlossee, metcalfi,* and *glutinosus* in each of three regions: the Black Mountains (2 and 3) , White Top (16) , and Grandfather (8) . This is a vexatious problem because the name "metcalfi" occurs in the literature in more than one sense, and the ecological relationship of *glutinosus* to the population herein considered to be the true *metcalfi (* Hairston and Pope, 1948, *fig.* 11) is not well understood. It should be kept in mind that, horizontally, the range of *glutinosus* completely embraces the combined ranges of the other two, whereas *metcalfi* is found over most of the range of *yonahlossee,* and

yonahlossee occurs over about half of the *metcalfi* territory. The map in Hairston and Pope *(loc. cit.)* illustrates this relationship, but it must be recalled that *metcalfi* is now known to range northward to Burkes Garden, Virginia (Hoffman and Kleinpeter, 1948, p. 605). See Figure 1.

Black Mountains (2 and 3). Here Hairston (1949, p. 54-55 and *fig.* 4) found *glutinosus* and *metcalfi* actually together in only two places, and the maximum vertical overlap in a single watershed was but 200 feet. When individual coves were taken into consideration, the vertical range of *yonahlossee* fell largely within that of *glutinosus* as well as almost entirely below that of *metcalfi*. The habitat restriction of *yonahlossee* reported by Hairston *(op. cit.,* p. 55) and discussed herein under the section on habitat makes it evident either that he failed to determine the complete distribution of *yonahlossee* or that the picture in the Black Mountains differs sharply from that in the northern part of the range, which will be taken up next.

Table IV. Relative Abundance of *P. yonahlossee, metcalfi,* and *glutinosus* on White Top (16)

Site, with altitude in feet	Man-hours of work	Number of each species taken
Top 5450-5520	6 by day 3 by night	1 of *yonahlossee* 28 (day), 3 (night) of *metcalfi* none of *glutinosus*
Southern side 3775-3900	6	5 of *yonahlossee* 50 of *metcalfi* 8 of *glutinosus*
Between Park and Green Cove 3400	0.5	none of *yonahlossee* 3 of *metcalfi* 3 of *glutinosus*
"White Top" 4000, 3500-450 and up to 3800, respectively, for the three species		6 of *yonahlossee* 60 of *metcalfi* 12 of *glutinosus*

White Top (16). We found *yonahlossee* at 5475 feet on the top, where (as explained in the section on incidence) it was rare, and at 3775 to 3900 feet on the lower southern face of the mountain, where it was common. ***P. metcalfi*** was exceedingly abundant on the very top (5450 to 5520 feet) as well as on the southern face (3775 to 3900) less than two miles to the west but still on the southern face (midway between Park and Green Cove) we found it fairly common at 3400 feet. ***P. glutinosus*** was taken at these same two places on the lower southern face al though, being confined to pastures bordering the woods and to the relatively open fringe of the latter, it was a little more restricted vertically (found up to 3800 feet). Table IV summarizes our results (achieved

under fairly good weather conditions) and includes Dunn's 1917 data for " White Top."

Our work on White Top was much too brief to give a complete picture, but it is clear that *metcalfi* and *yonahlossee* here have the same habitat and much the same vertical distribution, whereas *glutinosus* seems to be confined to the lower levels and to occupy a separate habitat that barely infringes on that of the other two. As Hairston has pointed out, data based on individual vertical transects rather than those compiled from varied, isolated observations must be used to obtain a true picture.

Grandfather Mt. (8). We did no work here and I know of no transects that have been made, but bringing together various observations gives a picture similar to that described for White Top, i. e., *metcalfi* common from the top to a level well down the sides and *yonahlossee* rare at the top but moderately abundant on the sides. Dunn (1917), working between Linville and Grandfather Mt. at 4200 feet, got 23 *yonahlossee* to 150 *metcalfi* and 47 *glutinosus;* later (1920) at Linville he got 8, 52, and 15 specimens, respectively. He (1920) states that *metcalfi* is the characteristic salamander of the (Linville) woods above 3000 feet. My son, Alex ander, collecting with a friend on Grandfather Mt. (for one day below and one above 5000 feet) found many *metcalfi* between 4000 and 5900 feet but secured only one *yonahlossee* (5700 feet) . The presence of *glutinosus* and *metcalfi* in the same woods about Linville and Grandfather Mt. (Dunn, 1917 and 1920; Pope, 1924) is of special interest and calls for further investigation in view of their ecological segregation elsewhere. The badly deforested nature of the region must not be forgotten. A transect carefully planned might help to clarify the situation; heretofore collectors have been too prone to work along and above the Yonahlossee Road where conditions are especially bad because of the primitive methods of lumbering that have been perpetrated there. Both lumbermen and herpetologists have found it all too accessible.

Habitat. With the exception of Hairston, who is considered separately, field observers of *yonahlossee* have stated that it inhabits wooded hills, valleys, and ravines, the adjective "damp" being included in more than one account (Dunn, 1917; Breder and Breder, 1923; Gray, 1939; Wood, 1947). Bailey (1937) found it common in a rock-filled ravine and Dunn (1920) took it in second-growth oak woods.

In sharp contrast, Hairston (1949, **p.** 55) explains in detail (text and figure) and as the result of the most detailed field study of *yonahlossee* yet published, that it is "restricted to a zone within 100 feet" of streams. His work, done in the Black Mountains (2 and 3) , leads to the conclusion that the species is confined to a special niche in the extreme southern part of the range. However, the failure of Bailey (1937) to note this fact

when working still farther south (locality 1) is puzzling to say the least. Hairston also noticed a predilection of *yonahlossee* for virgin forests.

My own observations confirm, amplify, and extend those of the earlier workers as shown by the following data.

Mixed deciduous, relatively dry woods with a predominance of oak trees grow along the crest of Iron Mt. (14) ; although the forest is not virgin, it is moderately thick and has a good ground cover of leafy debris and rotting wood. Here, within half a mile of the gap where U. S. Highway 421 crosses the crest of Iron Mt. and between 3900 and 4300 feet altitude, we found *yonahlossee* abundant in: (1) an area at the gap where the trees had been thinned out and the bare, rock-covered road embankment was largely exposed to the sun; (2) along a precipitous, south-facing talus slope of the crest southwest of and above the gap; (3) in woods of the steep to gentle southeast-facing slope just below the crest of the ridge northeast of and above the gap; (4) near a tiny (wet-weather?) spring stream in a wide, wooded valley a few hundred yards below the crest and on its northwestern slope. In short, the species was found in every forest-floor niche at this level and on both sides of the crest, even on the open, man-made road embankment, stone-covered but devoid of leafy debris.

In this same locality and only 1.4 miles by road from the gap, *yonahlossee* was taken abundantly on the northwestern slope of Iron Mt. (14) at an altitude of 3600 to 3900 feet and also near U. S. Highway 421. Here a small stream (Shady Branch) flows down a wide valley with mixed deciduous woods and a rocky, debris-covered floor. *P. yonahlossee* was more abundant along and near the stream, even in its log- and leaf-choked bed, than up on the high, steep slopes of the valley. The species was not lacking even in a part of the valley that had been largely cleared of trees in the not-too-distant past.

On the southeastern slope of Iron Mt. and still at locality 14, two specimens were found actually in an open pasture near which a stream flowed. The altitude was 3200 to 3300 feet.

In the Buck Mt. area (17), we found *yonahlossee* abundant in second-growth, mixed deciduous woods at 3500 to 3700 feet. This site was in a wide, rolling valley between ridges but far from a stream. The ground cover was good. Part of the steep eastern face of Buck Mt. is clothed in a dense growth of young birch trees. The floor, kept wet by numerous springs, is stony, boulder-strewn, and covered with much debris as well as a growth of bracken. *P. yonahlossee* was moderately abundant here at 4400 to 4600 feet. In confirmation of the discovery of two specimens in the Iron Mt. pasture, we found one on the very top of Buck Mt. a few feet from High Rock (4670 feet) , a huge, isolated rock surrounded by a pasture with rank grass and a dense growth of knee-high plants. It would be interesting to know just how far into such "bald" areas *yonahlossee* penetrates. The High Rock specimen was within two hundred

yards of the edge of the birch forest already described, and we did not find *yonahlossee* in the log-strewn, grassy slope (4300 to 4350 feet altitude) below the birch forest, although thirty-five specimens of two other species of woodland Plethodons were taken under decaying wood in this steep pasture during fifteen minutes.

At Comers Rock (18) *yonahlossee* abounded in the relatively dry, mixed deciduous second-growth forest that was largely oak. The altitude where we worked was 3600 to 3700 feet, and no stream was within view since the site was at the very crest of the ridge. The ground cover was good.

Finally, we collected *yonahlossee* with little trouble on the lower southern side of White Top (16) at 3775 to 3900 feet in mixed deciduous, second-growth forest where the ground cover was thick. In this case, all the specimens were taken near a large stream, four among five within 150 feet of the water. The scarcity of *yonahlossee* in the balsam-red spruce forest capping White Top has already been discussed in the section on incidence.

Habits. In the original account, Dunn (1917) writes of the great agility of *yonahlossee* in evading capture, its frequent use of burrows, and its way of hiding under logs and pieces of bark. Later (1926, p. 132) , he remarks that it occasionally hides between bark and wood of rotten logs. There has been ample confirmation of these observations, and cavities beneath stones have been added to its hideouts (Bishop, 1943, p. 287). Bailey (1937) found it easy to collect at night on both clear and rainy days.

We caught this salamander chiefly in and under rotting logs, under bark either on the ground or still undetached from its log, and under stones. Where stones were abundant it certainly did not shun them. The size of stone, log, or piece of bark seemed to make little difference. The preferred niche was old windfalls that had shed much of their bark to cover the ground round about; at a single windfall five or six specimens could be found hiding under the bark on the ground or under that still in place. The proximity of a stream made little difference: here the species was common along a stream, there in high, relatively dry woods. In Shady Branch valley (see section on habitat) of Iron Mt. (14) *yonahlossee* abounded in the log- and leaf-choked stream bed, whereas up on the crest of Iron Mt. ridge near the gap, it lived on the bare road embankment. Areas of light shade attracted it more than did those in the thickest woods.

I have avoided the word "burrow" because I fear the term may lead to the conclusion that this salamander habitually constructs burrows. As a rule, however, it probably uses cavities and burrows already formed in any one of various ways. No doubt it often reopens old passages largely obliterated, or it may even make new ones by forcing its way through very soft, porous surface covering.

Feeding. A study was made of the stomach contents of the series of adult *P. yonahlossee* and *P. glutinosus* collected at the same time and place (Iron Mt., 14) . In addition to showing what these forms eat, it was hoped that this study might give a clue to the way in which competition is avoided by two such similar species living in the same habitat niches.

Identifications were not carried further than the family since doing so would have obscured the issue by enormously extending the list of food items. Fragmentary material in the gut was disregarded.

Table V, by indicating the number of stomachs containing each food item, shows that both species feed indiscriminately on a great variety of invertebrates belonging to at least three phyla (arthropods, annelid worms, and molluscs) . No fewer than five classes of arthropods are represented (insects, arachnids, millepedes, centipedes, and crustaceans) .

The most striking difference between the two columns of this table is the greater number of soft-bodied forms recorded for *glutinosus,* but this may be completely invalidated by the fact that many if not all of the specimens of this form were preserved within twelve hours of capture, whereas those of *yonahlossee* were kept alive for from one to three days in order to study their coloration. Roughly, one-third were empty and somewhat less than a half were kept three days. In contrast, barely five per cent of the specimens of *glutinosus* had no food in the stomach. It behooves the student of dietary studies to preserve his material as soon as possible, certainly not more than 48 hours after capture.

Table VI compares the upper limits of size of the prey. There is some indication that *yonahlossee* captures more of the larger beetles, and in this way tends to avoid competition with *glutinosus,* but the indication is not too positive. At any rate, the table shows that, in spite of their soft skin, these species can overpower extremely formidable prey protected by hard cases, stings, malodorous substances, and so on. In fact, ants and hard beetles make up the bulk of the diet of *glutinosus* if not of *yonahlossee* as well.

One female *yonahlossee,* itself measuring only 77 mm. from snout to vent, had devoured a 45 mm. centipede and a millepede more than 25 mm. long; a female two millimeters shorter had swallowed an 18 mm. carabid beetle and a click beetle about half as long. Even a lizard would do well to devour such prey. In addition to being well protected by a scaly skin, the lizard has claws, which assist in manipulating or even in tearing prey, and crushing teeth. The salamander, though lacking these advantages, does have a good supply of sharp teeth in the upper jaw that undoubtedly hold the prey securely but, being largely unopposed, are of little use in mastication. The salamander teeth function somewhat like those of a snake.

Table VI. Size of Larger Prey of *Plethodon yonahlossee* and *P. glutinosus* Compared.

	P. yonahlossee	*P. glutinosus*
Arthropoda		
Insecta		
Unidentified larvae	10+	15
Orthoptera		
Acrididae (grasshoppers)	14, 18	
Homoptera		
Membracidae (tree-hoppers)	10	
Hemiptera (bugs)	16	
Lepidoptera		
Heterocera (moths)		15, 15+, 20
Miscellaneous larvae	20+	13, 15, 20+, 20+, 25, 40+
Diptera		
Tipulidae (crane flies)	12, 12, 15	
Unidentified larvae	10	
Coleoptera		
Buprestidae	13, 20	
Cantharidae		15
Carabidae (ground beetles)	10, 10, 10, 15, 15, 16, 16, 16, 16, 16, 17, 18	14, 15, 15, 16, 20
Cerambycidae (long horn wood-borers)	12, 15	
Elateridae (click beetles)	10, 12, 12, 14, 14, 14, 14, 15	10, 10, 12, 14, 15
Scarabaeidae (scarabs)	10, 10	10, 10+
Staphylinidae (rove beetles)		12
Tenebrionidae (darkling beetles)		10
Miscellaneous beetles	10	18
Miscellaneous beetle larvae		10, 10, 10+, 12, 12
Hymenoptera		
Formicidae (ants)	10, 10, 10, 12, 1	10,10, 10, 10
Vespidae (wasps)		12
Diplopoda (millepedes)	15, 15+, 15+, 20+, 25+	12, 15, 15+, 15+, 20+
Chilopoda (centipedes)	45	10, 15+, 25
Annelida (earthworms)		30+, 40+,50+,50+,55+
Mollusca		
Pulmonata (snails)	10	

This table lists food items of the preceding table that are ten or more millimeters long, the numerals in the two columns indicating the length of the individual items. Since several stomachs contained more than one large item, the number of measurements here does not correspond to the number of stomachs, except in the case of ants, which are too numerous to list individually. Measurements for the most part are approximations.

The ability to swallow a large, hard object is also astonishing: a female *yonahlossee* measuring 67 mm. from snout to vent and having a width and depth of 8.5 and 6.5 mm. in the neck region, had eaten a snail 9 mm. in diameter and 5.5 mm. high. The snail *(Stenotrema edvardsi)* was not crushed and its shell was "velvety," a type of shell that presumably would be anything but easy to swallow.

The quantity of food found in one stomach may be great. A female measuring 77 mm. from snout to vent had eaten fifteen invertebrates: 3 mites; 1 small spider; 2 snails (4 mm. each) ; 2 ants, one 9 mm. long; 1 crane fly (12 mm.) ; 3 click beetles, each about 14 mm. long; 1 small metallic wood-borer; and 3 other beetles from 4 to 10 mm. long.

It is obvious that these two salamanders must be rated as highly important vertebrate predators on the invertebrates of the forest floor. Mammals and birds are probably their only vertebrate rivals, since reptiles and other amphibians are relatively rare in these forests. It would be interesting to know just how often a salamander fills its stomach and whether salamanders feed during the dry spells when the collector finds them so much less abundant than during rainy ones. Do breeding activites interfere with regularity of eating?

The two previous studies of *glutinosus* stomach contents summarized by Bishop (1941, p. 227-228) are in essential agreement with the present one. Rankin (1937, p. 181) found centipedes, ants, and beetles in *yonahlossee* stomachs; he apparently dissected three specimens.

Parasites. Rankin (1937) has reported five species of Protozoa, one of Nematoda, and one of Trematoda that are parasitic on *P. yonahlossee.*

SIZE, GROWTH, AND THE SEXES

Size at Sexual Maturity. The cloacal gland papillae and the mental gland of the males give a clue to the size at which sexual maturity is reached.

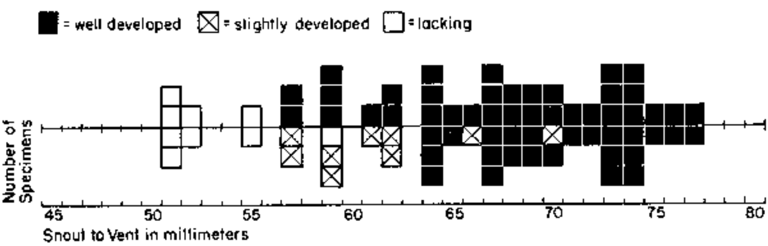


Figure 2. Cloacal gland papillae (above line) and mental gland (below line) correlated with snout-vent length of Iron Mt. (14), Buck Mt. (17), and Comers Rock (18) series.

Cloacal gland papillae. All males more than 56 mm. in snout-vent length have these papillae (Fig. 2) , so I assume that their absence is due to immaturity rather than to season. I have not attempted to distinguish

Table V. Stomach Contents of *Plethodon yonahlossee* and *P. glutinosus* Compared.

	P. yonahlossee	*P. glutinosus*
Arthropoda		
Insecta		
Miscellaneous insects	L 1	L 2
Collembola (springtails)	1	12
Orthoptera		
Acrididae (grasshoppers)	2	
Blattidae (roaches)	1	
Isoptera (termites)	1	
Corrodentia		3
Homoptera		
Membracidae (tree-hoppers)	1	3
Cicadellidae (leaf-hoppers)		1
Hemiptera		
Miridae (plant bugs)		1
Pentatomidae (stink bugs)	1	
Cydnidae	1	
Miscellaneous bugs	2	1
Lepidoptera	L 1	L 6
Heterocera (moths)		3
Diptera		
Asilidae (robber flies)		1
Culicidae (mosquitoes)		L 1
Tipulidae (crane flies)	3	
Miscellaneous flies	1 L 6	5 L 9
Coleoptera		
Buprestidae (metallic wood-borers)	3	
Cantharidae		1
Carabidae (ground beetles)	10	8
Cerambycidae (long horn wood-borers)	2	
Curculionidae (weevils)	1	1
Elateridae (click beetles)	6	5
Lathridiidae		1
Nitidulidae	1	
Pselaphidae	1	
Scaphidiidae		1
Scarabaeidae (scarabs)	2	3
Staphylinidae (rove beetles)		2
Tenebrionidae (darkling beetles)		1
Miscellaneous beetles	5 L 2	6 L10
Hymenoptera		
Formicidae (ants)	30	35
Vespidae (wasps and hornets)		2
Unidentified hymenopteran		1
Arachnida		
Phalangida (daddy long legs)		2
Chelonethida (pseudoscorpions)	2	4
Araneida (spiders)	2	17
Acarina (mites)	5	11
Diplopoda (millepedes)	5	7
Chilopoda (centipedes)	1	5
Crustacea		
Isopoda (sow bugs)	1	
Annelida		
Lumbricidae (earthworms)		6
Mollusca		
Pulmonata (snails)	8	12

Analysis of stomach contents of the Iron Mt. (14) series of fifty adult *P. yonahlossee* 57 to 85 mm. snout to vent) and fifty-eight adult *P. glutinosus* (60 to 71 mm. snout to vent). The numerals indicate the number of stomachs in which each food item was found. Records of larval forms are preceded by an "L".

between "slightly" and "well-developed" papillae. Superficial examination of the testes places the line between mature and immature specimens at this same place.

Mental gland. This gland is never seen in specimens less than 56 mm. long (Fig. 2) but it may be lacking or only slightly developed in larger individuals (59 and 70 mm., respectively).

As in the case of ***P. glutinosus (*** Pope and Pope, 1949) the cloacal gland papillae are the more useful in determination of sex after a little practice in finding them. They are also more reliable as a criterion of maturity.

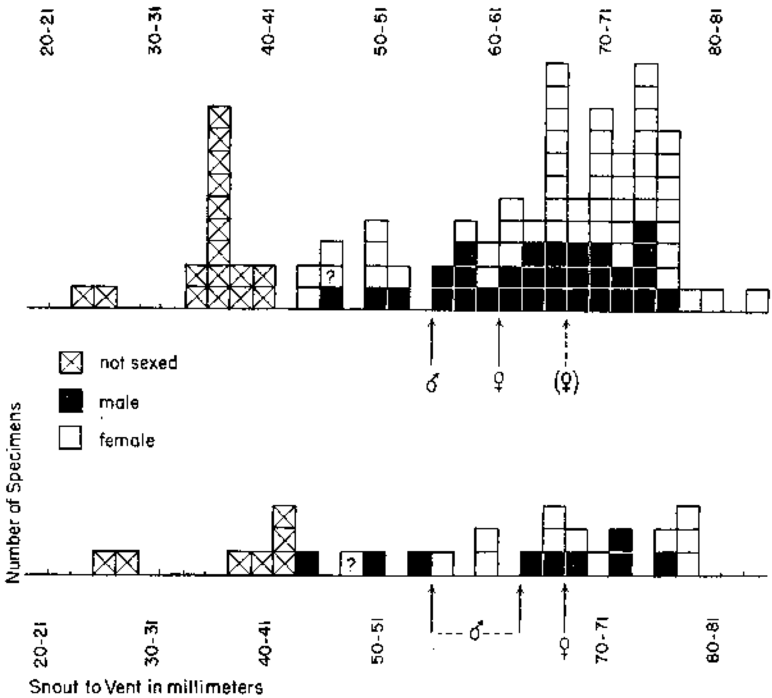


Figure 3. Size (snout-vent) distribution of 100 Iron Mt. (14) and 28 Virginia (localities 16, 18, and 19) specimens shown by two histograms. Solid vertical arrows indicate size at maturity for the sexes, whereas the dotted vertical arrow indicates for females an alternative size based on a single 66 mm. specimen that still seemed to be immature.

Rate of *Growth.* When the series of 100 Iron Mt. (14) specimens collected at the same time is placed on a histogram (Fig. 3) clearly distinct age groups are not evident. However, three groups are discernible, the first two of which probably represent individuals in their second and

third seasons, i. e., the first and second summers after the one in which they were hatched. It is doubtful if any young of the year are in this series, since the collection was made July 12-14 at which time hatchlings of the year would have had little time to grow, and certainly a salamander of the size of *yonahlossee* could not hatch at 50 mm., the total length of the smallest in the series. A protracted breeding season (see section on breeding season) could account for the great range of size included in each of the lots of the first two seasons and the lack of more clearly discernible groups.

The third and larger group is apparently composed of adults. The logical conclusion is that *yonahlossee* attains sexual maturity by the fourth season of life when almost three years old.

A histogram for the 28 White Top, Buck Mt., and Comers Rock specimens has been put on Figure 3 for the sake of completeness. This Virginia material was collected later (August 10-17) .

Sexual Dimorphism in Length. Sexual dimorphism in length is just noticeable in *P. yonahlossee* as shown by Table VII based on our series of Iron Mt. (14) specimens.

The maximum total length of males and females, respectively, among our series of 128 individuals is 162 and 177 mm.

Table VII. Snout-vent Length of Mature *P.* *yonahlossee*.

	Number	Extremes	Mean
Males	27	57-76	67 ±1.13
Females	40	63-85	72 ±0.75

Sexual Dimorphism in Shape of Snout. The male has a pronounced swelling of the upper lip below each naris, whereas the female has a similar but much less noticeable one.

Relative Number of the Sexes. The Iron Mt. (14) series includes 83 specimens measuring more than 44 mm. from snout to vent, and therefore more or less readily sexed. These are made up of 40 mature females, 27 mature males, 12 immature females, 3 immature males, and one juvenile that is probably a male. The Virginia series (localities 16, 17, and 18) of only 21 individuals of the same size range as the larger Iron Mt. lot do not show this marked preponderance of females. A conclusion based on such a small series is hardly justified but the difference in time of collecting on Iron Mt. (July 12-14) and in Virginia (August 10-17) is worthy of mention in this connection. A larger number of females guarding their eggs might well bring about a relative scarcity of that sex in collections.

REPRODUCTION

Breeding Season. Examination of the ovaries and oviducts of the Iron Mt. (14) series, which was taken July 12-14, reveals a lack of uniformity in condition that makes the drawing of a conclusion difficult. Many of the ovaries are packed with large ova, whereas others, not thus packed, have ova of various but mostly smaller sizes. The oviducts are seldom noticeably swollen and convoluted. All this suggests that the laying had not yet begun; only three of the seven adult females collected about a month later (August 11-17) in Virginia (localities 16, 17, and 18) have ovaries packed with very large ova, and oviducts that are swollen and much convoluted. These obviously are about ready to ovulate, but the remaining four adult females present a varied picture: some oviducts are a little swollen, whereas others are not, and the ova are various in size and number. Series collected at much greater intervals are needed.

The conspicuous mental glands of the males suggest sexual activity. On August 11 I collected on White Top (16) four specimens by pairs; each pair was under a piece of rotting wood small enough to suggest a temporary hideout, i. e., as if the courtship in each case had been interrupted by the coming of daylight. Both males had a very conspicuous mental gland. The only other specimen taken that day was a juvenile.

Dr. L. James Kezer informs me that he found a good spermatogenic wave in the anterior third of a testis fixed May 25, the wave presumably having started at emergence from hibernation. This condition is similar to the one he saw in ***P.** glutinosus* from central New York state.

The height of the extensive laying season of *glutinosus* appears to be during the first part of August (Pope and Pope, 1949) .

In this connection, a confirmatory observation of a courtship dance of *glutinosus* is worth recording. It took place near the laboratory building of Mountain Lake Biological Station, Giles County, Virginia, at 8:30 P. M. on August 19, 1949. Dr. H. K. Wallace saw one individual following the other in a circle while keeping its chin on the slowly undulating tail of the leader. The dance continued for some minutes while I was being called, but the pair separated and dashed for cover with astonishing agility soon after my arrival. Both were captured but with much difficulty. They had circled on the bank of the road within a bare area of a few square feet.

Fecundity. Some indication of the number of eggs laid at a time may be gained from the following counts of advanced ova in the three large (77 to 78 mm. snout to vent) *yonahlossee* collected August 11-16 in Virginia (localities 16 and 18) : 27, 19, and about 24. These meager data give a mean of 23 per female, which is the same as that for ***P.** glutinosus* (Pope and Pope, 1949).

VARIATION

Variation in Color. Little or nothing has been added to Dunn's excellent original description. This is largely because no big series have been available for long. Examination of my series brings to light certain new color characters and some signficant variation in old ones. These characters must be considered before a true picture of relationships among the large Plethodons can be drawn.

Sexual dimorphism in color has not been detected.

No species better illustrates the necessity of basing descriptions on living material. It has long been known that the two most conspicuous elements in the pattern of *P. yonahlossee,* the red of the dorsum and the lateral white spotting, largely or entirely disappear in preservative. This fact cannot be repeated too often since even contemporary workers are sometimes careless about making a clear distinction between fresh and preserved specimens. A typical living specimen of *yonahlossee* can scarcely be confused with any other kind, whereas preserved ones can be easily confused with several other forms.

In the following descriptions the adult condition is meant except as otherwise indicated.

Back. The Iron Mt. (14) series of 100 specimens was examined just after preservation and before any change could have taken place; the evanescent nature of the red dorsal band is well known (Dunn, 1917) . An arbitrary line was drawn in the field (where it was impossible to sex and accurately measure so many specimens) at about 50 mm., snout-vent measurement, the 75 members of the larger size-group being rated as adult. The vast majority of these adults had immaculate red backs or red backs with traces of faint black suffusion or from one to five small black spots. This majority might be termed "normal." It was hard to make a sharp distinction between the immaculate red ones and those not so. One specimen had no red whatsoever on the (black) back and five lacked it in varying degrees: in one a third of the back was black, in two there was conspicuous suffusion of black in the red, in one conspicuous black mottling, and in another a big black area across the back anteriorly, and black suffusion elsewhere. In short, 8 per cent lacked a good red dorsal stripe (5 specimens) or had no stripe at all (1 specimen). Among 13 adults from Buck Mt. (17) and Comers Rock (18) , three belonged to this 8 per cent category with a poorly developed red stripe.

It should also be remarked that the red stripe varies noticeably in hue from specimen to specimen, but lack of a good color standard prevented me from making accurate field notations.

Top of head. The Iron Mt. (14) series (adult and young) , was examined within 24 hours of preservation and the heads of 29 (including but one very small individual) were uniform black; of 35, black with a

few light, widely scattered specks; of 29, with profuse specks; of 7, with very profuse specks.

Sides. In life, the lateral spots, so profuse that they form a band, strongly suggest the condition seen in *glutinosus* of some areas, but, on Iron Mt., *glutinosus* had no such lateral profusion, and the species could always be distinguished by comparing the sides.

The evanescent nature of the lateral spots of *yonahlossee* was pointed out by Dunn (1917). The spots of *glutinosus* persist as indeed those of *yonahlossee* sometimes do. In my series, preserved now several months, are individuals retaining conspicuous lateral spots and others lacking them entirely. In the latter, light areas due to the absence of black pigment have been unmasked, as it were, on the lower sides and even the lateral aspect of the belly. These persistent light areas are strongly suggestive of those seen in *P. wehrlei.* Some *preserved* specimens of these two species indeed bear a deceptive resemblance to each other.

Belly. It is an odd fact that the belly of *yonahiossee* has been described as immaculate. Dunn (1917 and 1926, p. 131) states that it is immaculate, lighter than the (black) back, lighter than the belly of *glutinosus,* darker than the belly of *metcalfi.* Bishop (1943, p. 289) describes it as bluish-gray but goes on (p. 290) to say that, in long-preserved individuals, it is "grayish or brownish mottled and blotched with lighter areas."

My Iron Mt. (14) series exhibited in life and does so now (after several months of preservation) small ventral spots irregular in size and shape and more profuse laterally than medially. In their extreme development, they give the belly a mottled appearance. See Figure 4. They are probably the "lighter areas" of Bishop's preserved specimens. Tabulation of these light spots on the 67 mature Iron Mt. specimens gives the following results:

Virtually lacking	4 specimens
Few and widely scattered	8 specimens
Moderately profuse (standard: CNHM 59389)	33 specimens
Profuse (standard: CNHM 59350)	17 specimens
Very profuse	5 specimens

This character well serves to distinguish *yonahlossee* from the series of *glutinosus* collected at the same time and place. Only about 2 per cent of 110 specimens of this *glutinosus* series have enough of this ventral spotting to cause possible confusion with the 12 *yonahlossee* of the first two categories. Normally, the belly of *glutinosus* entirely lacks such spotting.

Throat. Dunn (1917) and others have remarked that the throat of *yonahlossee* is lighter than that of *glutinosus.* In my Iron Mt. (14) series of *yonahlossee* (preserved a few months), the relatively light throat nearly always shows faint dark mottling, which is more pronounced in some 25

per cent of the specimens. Bailey (1937) states that the throat is frequently mottled. The *glutinosus* throat (Iron Mt. series) is rarely almost as light as a dark-mottled *yonahlossee,* and the *glutinosus* throat frequently has numerous small white spots, a condition that is not evident in my Iron Mt. *yonahlossee* but is exhibited by a specimen from the vicinity of Celo (4). A well-developed mental gland of male *glutinosus* may give a false impression of lightness to the throat.

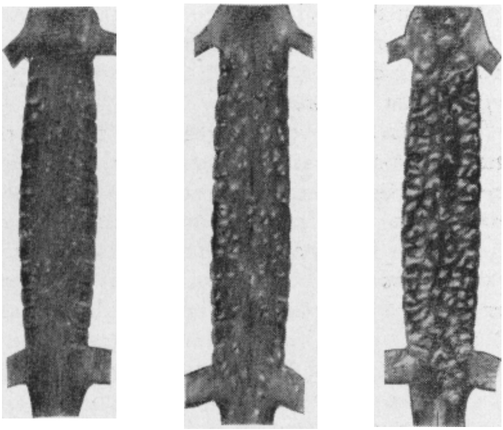


Figure 4. Variation in the belly coloration of Iron Mt. (14) *Plethodon yonahlossee:* light spots virtually lacking (left, CNHM 59386); moderately profuse (middle, CNHM 59389); very profuse (right, CNHM 59380).

Legs. Although the coloration of the legs is characteristic, it has barely been mentioned in the literature. Bishop (1943, p. 289) writes: "Fore legs light gray with a few small light spots, hind legs darker gray, lightly flecked; toes flesh color."

The legs in life usually exhibit conspicuous red spots suggestive of those of *P. s. shermani.* These spots are larger, more numerous, and more often present on the fore legs than on the hind ones, and they vary greatly in position, size, and shape. Tabulation made within 24 hours of preservation of my series from Iron Mt. (14) follows:

	Adults	Juveniles
Trace of red on at least one *leg*	54	9
No trace of red on any leg	20	17

The difference between adults and juveniles may be due partly to the difficulty of field examination of such small specimens; at best it is often hard to decide whether a trace of color is present. Among five White Top (16) specimens, examined at time of preservation, the four adults had at least some red on three limbs, and in two the red was conspicuous

on two limbs; the juvenile had traces of red on the fore legs only. Among 14 adults and juveniles from Buck Mt. (17) and Comers Rock (18) , also examined at time of preservation, five had some red on all four legs, six on at least two legs, and one had it on a single leg, whereas only two lacked red entirely.

Re-examination of this lot of 14 after a few months of preservation proves that the red faded or even disappeared on some legs but is still evident on others. The red of the back and that of the legs seems to persist or disappear together and therefore must be similar. The red pigment of the legs in ***P. s. shermani*** shows after years of preservation in some specimens, whereas it fades in others. It is undoubtedly more persistent than the red leg pigment of *yonahlossee.*

The legs of *yonahlossee* have, in addition to the red pigment, many light or unpigmented spots or areas. These light areas are nearly always larger and more numerous on the ventral surface than on the dorsal (when the leg is viewed from above slightly in advance of the perpendicular, slightly to the rear of it from below) . The posterior part of the ventral aspect nearly always has an especially conspicuous light area. An occasional specimen has an equal amount on upper and lower aspects. In the Iron Mt. (14) series of *glutinosus,* the reverse condition is evident, i. e., the corresponding dorsal aspect has more or larger white spots than the ventral, which lacks the posterior, especially large light area. A n occasional individual has an equal amount of light spotting above and below as in *yonahlossee* and therefore *yonahlossee* and *glutinosus* cannot invariably be separated by the distribution of light areas on the legs. It should be noted that this *leg* pigmentation is a reflection of that of the rest of the dorsal and ventral surfaces. This correlation is most striking in preserved material after the evanescent lateral light spotting of *yonahlossee* has faded or vanished. The difference between the spots of *yonahlossee (* sides) and *glutinosus* (back) is again brought out.

Juvenile back. As in the adults, all color notes were made not more than twenty-four hours after preservation.

Dunn (1917) described the paired red dorsal spots of juvenile *yonahlossee* and considered them reminiscent of a larval life. These spots, as he pointed out, are basically due to an absence of black pigment. However, the red pigment in them appears to be a forerunner of the red color that later covers the entire back. This red of the spots may develop first, and it seems to be more persistent in preservative. (Histological investigation would be required to settle this matter.) The back of the juvenile, wherever the black pigment has developed, is at first only suffused with the red that will later mask the black, even completely covering it in some individuals.

A few characteristics of these juvenile spots should be brought out to substantiate the theory of their origin: 1. They may be all but lacking.

For example, in my series one juvenile among six specimens measuring 34 mm. or less in length from snout to vent (70 mm. in total length) virtually lacks these spots. 2. Although essentially paired, they are very variable in intensity of color, number, size, shape, and distribution. 3. They persist to various levels of growth, being discernible in only eight among seventeen juveniles of my series measuring from 34 to 43 mm. snout to vent (70 to 89 mm. total length). One puzzling individual from Iron Mt. (14) has not been included in this tabulation: it lacked in life all signs of dorsal red pigment and paired spots. The snout-vent measurement is 36.5 mm. (74 mm. total length). A similar adult is mentioned above, but the absence of the dorsal spots makes this juvenile especially interesting. Comparison with my large series of *glutinosus* from the same locality erases doubt as to its identity.

Juvenile belly. The young have light bellies as in the related species. Stages intermediate between the light juvenile and the dark adult condition are exhibited by specimens from 45 to 51 mm. in snout-vent measurement (95 to about 105 mm. total length). The largest individual with a light belly measures 50 mm., the smallest showing the adult condition, 46 mm. These data are based on the Iron Mt. (14) series of 100 individuals.

Is it possible that any protective value can be attached to the pattern of *yonahlossee?* Does the red back make the species less conspicuous to such animals as skunks and raccoons? The assumption that skunks and raccoons prey on *yonahlossee* may not even be warranted. The nocturnal habits and lack of color vision of these mammals are other factors that make this an interesting predator-prey problem.

Vomerine Teeth Counts Correlated with Body Length. Counts of the vomerine teeth were made on 125 specimens, 99 from Iron Mt. (14) and 26 from localities 16, 17, and 18. The sums of the right and left counts, arranged graphically, are shown in Figure 5. One juvenile has only six teeth on a side and measures but 27 mm. from snout to vent. No specimen has fewer teeth than this one. The large female with the 21-22 count is perhaps abnormal. The next highest counts for one side are five 20's but these involve as many specimens.

The mean number of teeth for the 33 mature males (57 to 77 mm. snout-vent) and the 47 mature females (63 to 85 mm. snout-vent) are 28.4 ±0.68 and 30.9 ±0.61, indicating lack of a sexual difference except a little that probably is only a reflection of the slightly greater size of the female.

Dunn (1926, p. 130) gives 17 as the number of teeth in each series, whereas Bishop (1943, p. 289) states that the specimens examined by him had from 10 to 14 on a side.

Variation in Costal Groove Counts. The normal count is variously given as 14 (Dunn, 1926, p. 130) and 15 (Bishop, 1943, p. 289), depend-

ing on the way the count is made. Among my series of 67 Iron Mt. (14) adults, only four exhibit appreciable variation, i. e., they are most reasonably considered to be short one groove. Even this result is not too definite because of the complex shape of the inguinal groove. Sometimes it resembles a V, at others a Y, and the branches may be more or less widely separated so as to suggest two grooves. Variation of a magnitude of one or two grooves will be meaningless unless the same worker has made all counts and done so with great care.

Although the number of costal grooves between the appressed toes is a handy character for general use in keys it is not precise enough to be of value in variation studies of structurally similar forms.

Variation in Relative Tail Length. Table VIII, based on the entire series of 128 individuals, shows the length of the tail expressed in percentage of snout-vent length of (1) all mature specimens, of (2) the smallest specimens (25 to 43 mm. snout-vent) of the immature group. The many individuals with incomplete tails were necessarily omitted.

Table VIII. Tail Length Correlated with Length from Snout to Vent.

	Number of specimens and snout-vent range in millimeters	Tail/snout-vent length (%) Extremes	Mean
Mature ♂	23 (57-77)	96-135	117 ±1.93
Mature ♀	24 (63-85)	108-138	121 ±1.57
Immature ♂ & ♀	15 (25-43)	100-123	111 ±1.77

The two smallest specimens (25 and 28 mm. snout to vent) have body and tail equal in length but an individual only 39 mm. long already has a tail that measures 123 per cent of the snout-vent length. More data on near hatchlings are needed.

The tail of the female is but slightly longer than that of the male both absolutely and proportionately. Probably body and tail are at first about equal in length but the growth of the tail is relatively faster than that of the body.

SUMMARY

Field studies of *Plethodon yonahlossee,* a primitive species of its genus, were made at four carefully selected localities in Tennessee and Virginia, and a series of 128 individuals collected and preserved. A statistical study of growth, reproduction, and feeding habits was based on this series.

The distribution, both horizontal and vertical, as shown by the map (Fig. 1) , is thought to be very nearly complete. Contrary to the impression given by the literature, *P. yonahlossee* is abundant over much of its range except at high altitudes, where it is rare.

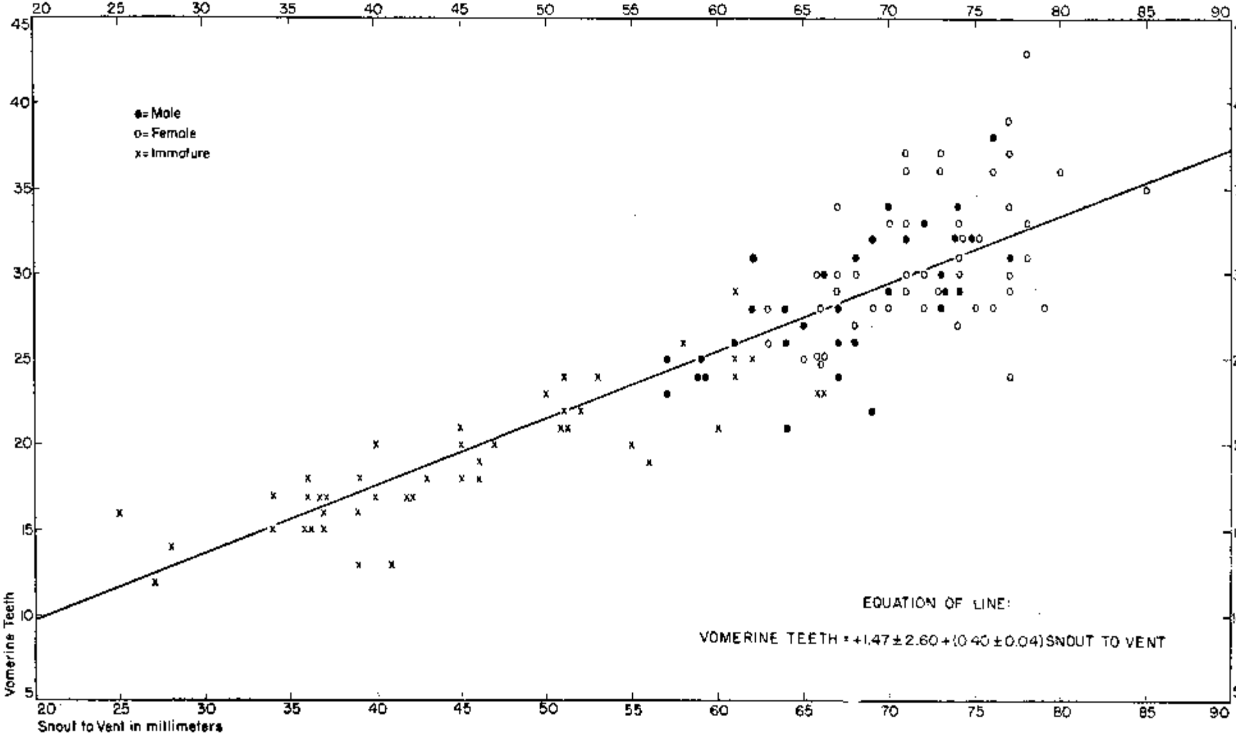


Figure 5. Number of vomerine teeth plotted against snout-vent length in 125 specimens of *Plethodon yonahlossee.*

The complex association of ***P. yonahlossee, P. glutinosus,*** and ***P. metcalfi*** is discussed at length. In regions devoid of the last species, *yonahlossee* and *glutinosus* have remarkable similarity in vertical range as well as in choice of habitat niches. This points to some highly effective isolating mechanism. Where *metcalfi* enters the picture (over most of the *yonahlossee* range) , the association is greatly complicated by the incomparability of *metcalfi* and *glutinosus,* the latter being excluded from the higher forests, presumably by the former. ***P. yonahlossee,*** in contrast, is closely associated with *metcalfi* except at the higher altitudes, where *metcalfi* alone remains abundant and *yonahlossee* rapidly decreases in numbers until it all but disappears. ***P. metcalfi*** and *glutinosus,* then, are incompatible, whereas *yonahlossee* can compete well with either one and must be reproductively isolated from both.

P. yonahlossee is a woodland salamander that frequents various habitat niches of the forest floor; these may be either dry or moist. Even grasslands adjacent to forests are invaded. It lives in and under rotting logs and under their loose bark, under pieces of bark and wood of various sizes, and under stones. The vicinity of old windfalls is a favored situation. It is an especially agile species.

P. yonahlossee feeds on a great variety of invertebrates, being indifferent to hard cases, stings, and malodorous substances. Prey of relatively great size is devoured. Ants and beetles are preferred items. The food of a series of ***P. glutinosus*** collected with *yonahlossee* proved to be similar to that of *yonahlossee;* the chief apparent difference can probably be accounted for by the difference in time of preservation of the material involved. It is possible that *yonahlossee* captures somewhat larger and more active prey, and in this way avoids competition by taking advantage of greater size and agility.

Secondary sexual characters of *yonahlossee* indicate that males reach maturity when they measure 56 mm. from snout to vent. Both sexes attain maturity by the fourth season of life at an age of almost three years. Females somewhat exceed males in adult size, the former averaging 72 mm. in snout-vent length, the latter 67 mm.

The usual sexual difference in shape of the snout is well developed in *yonahlossee.*

Females greatly outnumbered males in a mid -July collection but not in a mid-August one. The explanation of this difference is not clear.

Examination of oviducts failed to give conclusive evidence of the extent of the breeding season but suggested an extensive one with a peak in late August or early September. Secondary sexual characters of the male and other evidence point to summer mating. An August courtship dance of ***P. glutinosus*** is recorded.

Advanced ova in three *yonahlossee* females numbered 27, 19, and about 24.

A detailed analysis of the variation in coloration of the back, head, sides, belly, throat, and legs was made for the most part from living or freshly preserved material. Ontogenetic changes of belly and back were given due consideration. The complexity of the *yonahlossee* coloration is pointed out; also the fact that the simpler coloration of many of its relatives can be readily derived from that of this primitive form.

The number of vomerine teeth is shown to increase with size, and to exhibit considerable variation. The average number for adult males is 28.4, for adult females 30.9, the little difference probably being a reflection of the slightly greater size of the females.

Variation in costal groove count is shown to be slight. The tail length, expressed in percentage of the snout-vent dimension, is very variable, ranging from 96 to 138 per cent.

LITERATURE CITED

Bailey, Joseph R.

1937 **Notes on plethodont salamanders of the southeastern United States. Occas. Papers Univ. Michigan Mus. Zool., no.** 364, **p.** 1-10.

Bishop, Sherman C.

1941 **The salamanders of New York. New York State Mus. Bull., no.** 324, p. 1-365, fig. 1-66.

1943 **Handbook of salamanders. Ithaca (New York): Comstock Publ. Co., xiv+** 555 p., 144 fig.

Breder, Charles M. and Ruth B.

1923 **A list of fishes, amphibians and reptiles collected in Ashe County, North Carolina. Zoologica,** vol. 4, no. 1, p. 1-23, fig. 1-8.

Deevey, Edward S.

1949 **Pleistocene research** 3. **Biogeography of the Pleistocene. Bull. Geol. Soc. Amer.,** vol. 60, p. 1315-1416.

Dunn, Emmett Reid

1917 **Reptile and amphibian collections from the North Carolina mountains, with especial reference to salamanders. Bull. Amer. Mus. Nat. Hist.,** vol. 37, p. 593-634, text fig. 1-7, **pl.** 57-61.

1920 Some **reptiles and amphibians from Virginia, North Carolina, Tennessee and Alabama.** Proc. Biol. **Soc. Washington, vol.** 33, p. 129-138.

1926 **The salamanders of the family Plethodontidae. Smith College Aniv. Publ., viii+441 p., 86 fig.**

Gray, Irving E.
1939 An extension of the range of *Plethodon yonahlossee.* Copeia, no. 2, p. 106.

Grobman, Arnold B.
1944 The distribution of the salamanders of the genus *Plethodon in* eastern United States and Canada. Ann. New York Acad. Sci., vol. 45, p. 261-316, fig. 1-11.

Hairston, Nelson G.
1949 The local distribution and ecology of the plethodontid salamanders of the southern Appalachians. Ecol. Monog., vol. 19, p. 47-73, fig. 1-25.

Hoffman, Richard L. and Hubert I. Kleinpeter
1948 Amphibians from Burkes Garden, Virginia. Amer. Midl. Nat., vol. 39, no. 3, p. 602-607.

Hairston, Nelson G. and Clifford H. Pope
1948 Geographic variation and speciation in Appalachian salamanders *(Plethodon jordani* group). Evolution, vol. 2, p. 266-278, fig. 1-11.

Pope, Clifford H.
1924 Notes on North Carolina salamanders with especial reference to the egg-laying habits of *Leurognathus* and *Desmognathus.* Amer. Mus. Novit., no. 153, p. 1-15.

Pope, Clifford H. and Sarah H.
1949 Notes on growth and reproduction of the slimy salamander *Plethodon glutinosus.* Fieldiana, Zool., vol. 31, no. 29, p. 251-261, fig. 60-65.

Rankin, John S.
1937 An ecological study of parasites of some North Carolina salamanders. Ecol. Monog., vol. 7, no. 2, p. 169-269, fig. 1-15.

Wood, John Thornton
1947 Notes on North Carolina salamanders. Copeia, no. 4, p. 273-274.